

A RECORDING MEDIUM CARTRIDGE AND A RECORDING-AND-REPRODUCING
APPARATUS THEREOF

BACKGROUND OF THE INVENTION

5 1. FIELD OF THE INVENTION

The present invention relates to a recording-medium
cartridge equipped with a cartridge memory (a memory which can
exchange data in a contactless manner), and relates to a
recording-and-reproducing apparatus of the recording-medium
10 cartridge.

2. DESCRIPTION OF RELEVANT ART

A conventional recording-medium cartridge, which stores
a recording-medium, such as a magnetic tape, is equipped with
a cartridge memory. This cartridge memory mainly holds the
15 information, such as a serial number (production number) and
history information, which is unique information with regard
to the magnetic tape.

In this recording-medium cartridge equipped with the
cartridge memory, the exchange of data and the supply of power
20 are performed in a contactless manner. To be more precise, the
exchange of data between the cartridge memory and an external
device and the supply of power to the cartridge memory are
performed in a contactless manner by utilizing an
electromagnetic induction. Therefore, the cartridge memory is
25 stored in the cartridge case. As an example of these kinds
of the recording-medium cartridge, the recording-medium

cartridge disclosed in Japanese unexamined patent publication JP2001-332064 can be cited.

In this conventional recording-medium cartridge, the magnetic tape is allowed to perform the recording, reproducing, and correction of data. Thus, the authenticity of data cannot be certified, this is because the checking of whether data was falsified cannot be performed easily.

When data stored in the recording-medium cartridge is the data used in the medical field or legal field, the authenticity of data is required and the checking of the authenticity should be performed easily.

In the conventional recording-medium cartridge, additionally, since the readout of data from the magnetic tape is easily performed, if the recording-medium cartridge is stolen, the leakage of information becomes serious problem.

Therefore, the recording-medium cartridge, in which the authenticity of data recorded on the recording-medium (magnetic tape) is easily certified, and which can prevent the leakage of data recorded on the recording-medium (magnetic tape) even if the recording-medium cartridge is stolen, has been required.

SUMMARY OF THE INVENTION

The present invention relates to a recording-medium cartridge which stores a recording-medium and a cartridge memory. In this recording-medium cartridge, the cartridge

memory, which holds a unique cryptographic key in the condition that the rewrite of the cryptographic key is forbidden, is detachably attached to the recording-medium cartridge. The recording-medium holds a CRC-code and data which are correlated
5 with each other. Here, the CRC-code is generated based on the cryptographic key, and data is information to be recorded on the recording-medium.

In this recording-medium cartridge, since the cartridge memory is detachably attached to the recording-medium
10 cartridge, the recording-medium cartridge and the cartridge memory can be stored in separate places. Thus, the leakage of the data stored in the recording-medium cartridge can be prevented even if only the recording-medium cartridge is stolen. This is because the reproducing of data cannot be performed
15 without the cartridge memory.

In the recording-medium, a CRC-code, which is generated based on the cryptographic key and the data that should be prevented from the falsification, is recorded in the condition that the CRC-code correlates with the corresponding data.

20 Thus, the occurrence of the falsification of data recorded on the magnetic tape can be recognized even if the cartridge memory having another cryptographic key is installed in the recording-medium cartridge and the falsification of the data recorded on the recording-medium is performed. This is because
25 the CRC-code being recorded on the recording-medium disagrees with the reference CRC-code generated from the data obtained

from the recording-medium and the cryptographic key. Thereby, the checking of the falsification can be preformed by comparing the reference CRC-code with the CRC-code.

The present invention relates to a
5 recording-and-reproducing apparatus which performs a recording-and-reproducing of data against the above-described recording-medium cartridge. This recording-and-reproducing apparatus includes a CRC-code generator, a CRC-code recorder, a CRC-code comparator, and a reproducing controller.

10 In this apparatus, the CRC-code generator generates a CRC-code based on a cryptographic key, which is obtained from a cartridge memory stored in the recording-medium cartridge, and data entered from an external device, when performing a recording of data on the recording-medium. The CRC-code
15 recorder records the CRC-code on the recording-medium.

The CRC-code generator, additionally, generates a reference CRC-code based on a cryptographic key, which is obtained from the cartridge memory, and data obtained from the recording-medium, when performing a reproducing of data
20 recorded on the recording-medium. Then, the reference CRC-code generated by the CRC-code generator is compared with the CRC-code obtained from the recording-medium by the CRC-code comparator. The reproducing controller determines whether or not to allow the reproducing of the data recorded on the
25 recording-medium based on the comparison result of the CRC-code comparator.

In this apparatus, when performing the recording, the CRC-code is generated by the CRC-code generator based on the data entered from the external device and the cryptographic key obtained from the cartridge memory. Then, the CRC-code is
5 recorded on the recording-medium by the CRC-code recorder.

In this apparatus, when performing a reproducing, the data and the CRC-code are obtained from the recording-medium, and the cryptographic key is obtained from the cartridge memory. Then, the reference CRC-code is generated by the CRC-code
10 generator based on data and cryptographic key, and comparison of the reference CRC-code and the CRC-code is performed by the CRC-code comparator. Finally, the reproducing of data is allowed only when the reference CRC-code agrees with the CRC-code.

15 Thus, if the falsification of data is caused or if the reproducing of data is tried using the cartridge memory having a different cryptographic key, the reproducing of data cannot be performed. This is because the reference CRC-code disagrees with the CRC-code.

20 In the present invention, it is preferable that the recording-and-reproducing apparatus has a unique identification number. In this apparatus, the CRC-code is generated based on the data entered from the external device, the cryptographic key, and the unique identification number,
25 when performing a recording. Additionally, the reference CRC-code is generated based on data obtained from the

recording-medium, the cryptographic key, and the unique identification number.

In this apparatus, the CRC-code and the reference CRC-code are generated using the unique identification number in addition to data and the cryptographic key. Thus, the reproducing and falsification of data can be prevented even if the recording-medium cartridge and the corresponding cartridge memory are stolen. This is because the unique identification code is required for generating the CRC-code and the reference
10 CRC-code.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1A is a perspective view showing the magnetic tape cartridge.

15 FIG.1B is a plane view showing the cartridge memory being stored in the magnetic tape cartridge.

FIG.2 is a pattern diagram showing the construction of the data recorded on the magnetic tape.

FIG.3 is a block diagram showing the
20 recording-and-reproducing apparatus.

FIG.4 is a block diagram showing the recording-and-reproducing apparatus of another embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

25 FIRST EMBODIMENT

The preferred embodiment of the recording-medium

cartridge and the recording-and-reproducing apparatus according to the present invention will be explained. In the following explanation, a magnetic tape cartridge is used as an example of the recording-medium cartridge.

5 As shown in FIG.1A and FIG.1B, a magnetic tape cartridge 1 (recording-medium cartridge) is composed of an upper-half 1A and a lower-half 1B, which are put together into a single piece, and stores a magnetic tape MT and a cartridge memory 2 therein.

The cartridge memory 2 is an electronic part having a shape
10 of thin rectangular plate, and is composed of a base plate 2a, a loop antenna 2b, an IC-tip (not shown), and a globe top 2c. In this cartridge memory 2, the loop antenna 2b is provided on the base plate 2a using a printing technique and the IC-tip enclosed in a globe top 2c made of plastic sealant is connected
15 to a loop antenna 2b.

In this cartridge memory 2, the IC-tip holds a cryptographic key SK, which is determined arbitrarily, in the condition that the rewrite of the cryptographic key SK is forbidden. Additionally, the cartridge memory 2 is detachably
20 installed in the magnetic tape cartridge 1. Here, this installation of the cartridge memory 2 is performed through an inlet 1C. Thereby, the magnetic tape cartridge 1 and the cartridge memory 2 can be separately stored.

As shown in FIG.2, plurality of data D1, D2... are recorded
25 on the magnetic tape MT. In the region of data D1 on the magnetic tape MT, concrete information and a CRC-code are recorded in

the condition that the CRC-code and data adjoin with each other.
Here, the CRC-code (cyclic redundancy checking code) is a code
generated based on the cryptographic key SK recorded on the
cartridge memory 2 and the data to be recorded on the magnetic
5 tape. Other data following to data D1, such as D2 ... have the
same construction.

Hereinafter, the explanation about how to prevent the
falsification of data will be explained using the data D1 among
data to be recorded on the magnetic tape MT.

10 Here, the term "CRC-code" means that a cyclic redundancy
checking code, which is a digital error detection code used in
digital recording. In the present embodiment, "CRC-code"
corresponds to a remainder, which is obtained by dividing the
data by a specific constant number (CRC generator polynomial).

15 As shown in FIG.3, the recording-and-reproducing
apparatus 3 includes a CRC-code generator 31, a recorder 32,
a reproducer 33, a memory information reader 34, a CRC-code
comparator 35, and a reproducing controller 36.

The recording-and-reproducing apparatus 3 is connected to
20 an external computer 4. The external computer 4 supplies data
D1 to be recorded on the magnetic tape MT, which is stored in
the magnetic tape cartridge 1, to the CRC-code generator 31 of
the recording-and-reproducing apparatus 3. Additionally, the
external computer 4 outputs or reproduces the data obtained
25 from the magnetic tape MT in compliance with a command signal
entered from the reproducing controller 36.

When performing a recording of data on the magnetic tape MT, the CRC-code generator 31 generates a CRC-code C1 based on data D1 and cryptographic key SK, which is obtained from the cartridge memory 2 by the memory information reader 34. Then,
5 the CRC-code generator 31 supplies the CRC-code C1 and data D1 to the recorder 32.

When performing a reproducing of data, on the other hand, the CRC-code generator 31 generates a CRC-code C2 (reference CRC-code) based on data D1, which is obtained from the magnetic
10 tape MT, and cryptographic key SK, which is obtained from the cartridge memory 2. Then, the CRC-code generator 31 supplies the CRC-code C2 to the CRC-code comparator 35.

The recorder 32 performs the recording of the data D1 entered from the external computer 4 and of the CRC-code C1
15 generated by the CRC-code generator 31 on the magnetic tape MT, respectively.

The reproducer 33 obtains the CRC-code C1 and data D1 from the magnetic tape MT. Then, the reproducer 33 outputs the CRC-code C1 to the CRC-code comparator 35, and outputs data D1
20 to the external computer 4 and the CRC-code generator 31. The memory information reader 34 obtains the cryptographic key SK from the cartridge memory 2 and outputs the cryptographic key SK to the CRC-code generator 31.

The CRC-code comparator 35 compares the CRC-code C2
25 entered from the CRC-code generator 31 with the CRC-code C1 entered from the reproducer 33, and obtains a comparison signal

which indicates whether or not the CRC-code C1 agrees with the CRC-code C2. Then, the CRC-code comparator 35 outputs the comparison signal to the reproducing controller 36.

5 The reproducing controller 36 determines whether or not to allow the reproducing of data D1 recorded on the magnetic tape MT based on the comparison signal entered from the CRC-code comparator 35.

To be more precise, the reproducing controller 36 outputs the command signal, which allows the reproducing of data D1, 10 to the external computer 4, when the CRC-code C1 agrees with the CRC-code C2. On the other hand, the reproducing controller 36 outputs the command signal, which forbids the reproducing of data D1, to the external computer 4, when the CRC-code C1 disagrees with the CRC-code C2.

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RECORDING-AND-REPRODUCING BY THE RECORDING-AND-REPRODUCING APPARATUS

Next, recording/reproducing of data on/from the magnetic tape MT will be explained.

20 When performing a recording, the blank magnetic tape cartridge 1 is installed in the recording-and-reproducing apparatus 3. Then, the CRC-code generator 31 generates the CRC-code C1 based on data D1 and the cryptographic key SK entered from the memory information reader 34, when data D1 is 25 entered from the external computer 4. Next, the CRC-code generator 31 outputs data D1 and CRC-code C1 to the recorder

32. Then, the recorder 32 records data D1 and CRC-code C1 on the magnetic tape MT.

When performing a recording, the reproducer 33 obtains data D1 and CRC-code C1 from the magnetic tape MT, and outputs
5 data D1 to the CRC-code generator 31 and the external computer 4, respectively. The reproducer 33 simultaneously outputs the CRC-code C1 to the CRC-code comparator 35.

In this occasion, the memory information reader 34 obtains the cryptographic key SK from the cartridge memory 2 and outputs
10 the cryptographic key SK to the CRC-code generator 31. The CRC-code generator 31 generates the CRC-code C2 based on data D1 and the cryptographic key SK, and outputs the CRC-code C2 to the CRC-code comparator 35.

Then, the CRC-code comparator 35 compares the CRC-code C1
15 entered from the reproducer 33 with the CRC-code C2 entered from the CRC-code generator 31, and computes the comparison signal that indicates whether or not the CRC-code C1 agrees with the CRC-code C2.

Here, if data D1 is falsified and is changed to data D11,
20 the CRC-code C2, which is obtained based on the cryptographic key and data D11, disagrees with the CRC-code C1.

In this case, since the reproducing controller 36 outputs the command signal, which forbids a reproducing of data D11, to the external computer 4, the occurrence of the falsification
25 of data D1 can be recognized.

If the cartridge memory 2 and the magnetic tape cartridge

1 are stored in separate places, the falsification of the
CRC-code C2 cannot be performed. This is because the recording
and changing of data D1 on the magnetic tape MT cannot be
performed without the corresponding accurate cryptographic
5 key.

Thereby, the occurrence of the falsification of data D1
can be detected even if the falsification of data D1 and
CRC-code C1 is performed, when performing a reproducing of data
D1 using the cartridge memory 2.

10 Additionally, when the cartridge memory 2 and the magnetic
tape cartridge 1 are stored in separate places, a reproducing
of data D1 cannot be achieved even if only the magnetic tape
cartridge 1 is stolen and a reproducing of data D1 is tried by
using the cartridge memory having a different cryptographic key.
15 This is because the CRC-code C1, which is recorded on the
magnetic tape MT, disagrees with the CRC-code, which is
generated based on data D1 and the wrong cryptographic key.

According to the present embodiment, benefits as follow
can be obtained.

20 (1) Checking of the authenticity of data D1 on the magnetic
tape MT can be performed only by comparing the CRC-code C1,
which is recorded on the magnetic tape MT, with the CRC-code
C2, which is generated based on data D1 and the cryptographic
key SK.

25 (2) The leakage of data D1 recorded on the magnetic tape
MT can be prevented even if the magnetic tape cartridge 1

(recording-medium cartridge) is stolen. This is because the cartridge memory 2 can be detached from the magnetic tape cartridge 1, and can be stored in a place other than the place where a magnetic tape cartridge 1 is stored.

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SECOND EMBODIMENT

Next, second preferred embodiment of the present invention will be explained.

As shown in FIG. 4, the recording-and-reproducing apparatus 5 has a recording unit 57 in addition to a CRC-code generator 51, a recorder 52, a reproducer 53, a memory information reader 54, a CRC-code comparator 55, and a reproducing controller 56.

In this recording-and-reproducing apparatus 5, the function of the CRC-code generator 51 slightly differs from that of first embodiment. Here, the recording unit 57 is a device which holds a unique identification number (ID number) therein.

When performing a recording, the CRC-code generator 51 generates a CRC-code C3 based on the data D1 entered from the external computer 4, a cryptographic key SK entered from the memory information reader 54, and ID number entered from the recording unit 57. Then, the CRC-code generator 51 outputs the CRC-code C3 to the recorder 52.

When performing a reproducing, the CRC-code generator 51 generates CRC-code C4 based on data D1 obtained from the

magnetic tape MT, the cryptographic key SK entered from the memory information reader 54, and ID number entered from the recording unit 57. That is, the CRC-code generator 51 generates CRC-code C4 based on data D1, the cryptographic key SK, and the ID number. Then, the CRC-code generator 51 supplies the CRC-code C4 to the CRC-code comparator 55.

RECORDING-AND-REPRODUCING BY THE RECORDING-AND-REPRODUCING APPARATUS

Next, the motion of the recording-and-reproducing apparatus 5 will be explained.

When performing a recording, data D1 is entered to the CRC-code generator 51. Then, the CRC-code C3 is generated by the CRC-code generator 51 based on data D1, the cryptographic key obtained from the cartridge memory 2, and the ID number entered from the recording unit 57. Next, the CRC-code generator 51 outputs the CRC-code C3 and data D1 to the recorder 52. Thus, the CRC-code C3 and data D1 are recorded on the magnetic tape MT by the recorder 52.

When performing a reproducing, on the other hand, the CRC-code C4 is generated by the CRC-code generator 51 based on data D1 entered from the reproducer 53, the cryptographic key entered from the memory information reader 54, and the ID number entered from the recording unit 57.

Then, the CRC-code C4 is supplied to the CRC-code comparator 55. The CRC-code comparator 55 compares the CRC-code

C4 entered from the CRC-code generator 51 with the CRC-code C3 entered from the reproducer 53, and obtains a comparison signal which indicates whether or not the CRC-code C4 agrees with the CRC-code C3. Then, the CRC-code comparator 55 outputs the
5 comparison signal to the reproducing controller 56. The reproducing controller 56 determines whether or not to allow a reproducing of data D1 recorded on the magnetic tape MT based on the comparison signal entered from the CRC-code comparator 55. Then, the reproducing controller 56 outputs the command
10 signal, which indicates whether or not to allow the reproducing of data D1, to the external computer 4.

In the present embodiment, it is preferable that the cartridge memory 2, the magnetic tape cartridge 1, and the recording-and-reproducing apparatus 5 are stored in separate
15 places, respectively, when storing the magnetic tape cartridge 1. Thereby, the reproducing of data D1 can be prevented even if the cartridge memory 2 is stolen.

According to the present second embodiment, benefits as follows can be obtained.

20 (3) Since the CRC-code C3 is generated in consideration of unique identification number (ID number) and is recorded on the magnetic tape MT, a reproducing of data D1 cannot be performed if the magnetic tape cartridge 1, the cartridge memory 2, and the recording-and-reproducing apparatus 5, which
25 are used when performing a recording, are not used.

Thereby, the leakage of data D1 recorded on the magnetic

tape can be prevented even if the magnetic tape cartridge and the cartridge memory are stolen. This is because the reproducing of data D1 cannot be performed without unique identification number (ID number) of the
5 recording-and-reproducing apparatus 5.

Although there have been disclosed what are the patent embodiments of the invention, it will be understood by person skilled in the art that variations and modifications may be made thereto without departing from the scope of the invention,
10 which is indicated by the appended claims.

In the above described embodiment, the rewrite of the cryptographic key is not allowed in the recording-and-reproducing apparatus. But the recording-and-reproducing apparatus may adopt a memory
15 re-writing unit which changes the cryptographic key SK held in the IC-tip of the cartridge memory 2 in compliance with the command entered from an external device.

In the present embodiment, the recording-medium cartridge (magnetic tape cartridge), which adopts a magnetic tape, is
20 used as an example of the recording-medium. But, the present invention is not limited to this. For example, a magnetic disk and an optical recording disk can be adoptable as the recording-medium. Additionally, an optical recording tape may be adoptable instead of the magnetic tape.